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Tailor Made Screening Technology for different Screening Tasks in the Phosphate Industry

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Abstract

The paper will present an overview of specific requirements of the phosphate industry on screening processes and technology and in which way they can be met by choosing the right screening technology. Influencing parameters such as screen type, mesh or anti-clogging device on the production are described and discussed. Due to numerous developments in screening machines it becomes more difficult to decide for the right screen type and operating parameters. Nevertheless some parameters are of basic importance and will be the same for all screen types. These basic parameters for screening processes will be presented as well as different types of screening machines to demonstrate the way to decide for the best available technique.

Keywords: Screening technologies, fertilizer, bulk solids, prills, granules .

1. Introduction

The RHEWUM Company was founded in 1927 in Remscheid. The name is derived from “Rheinische Werkzeug und Maschinenfabrik” which can be translated as “tool and machine production company”. Our company has been dedicated to the production of screens for more than 60 years by now. Our goal is to set the quality standards in screening technology in order to realize the maximum customer satisfaction. Due to the constant improvements of our screen portfolio we are close to the market and able to react whenever new customer wishes have to be fulfilled. As a market leader in screening technology for fine particles such as fertilizers we have developed new screen types such as the “sonic screen” or the “multi deck screen”. We have developed screens that can handle very high loads and still produce very high qualities.

2. Basic knowledge about screening

In order to clarify the following calculations and assessments some basic theories for the interpretation of screening results will be explained. The main aim of a plant manager is to get as much product as possible with the highest quality. These wishes can be precised by two terms, the yield and the purity.

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The yield is defined as the amount of product generated referred to the amount of feed material:

$$Yield\ [\%] = \frac{Qty.\ of\ on-spec\ product\ in\ fraction}{Qty.\ of\ on-spec\ product\ in\ the\ feed} \tag{I}$$

The purity is defined as the amount of product in the product fraction referred to the total amount of product.

$$Purity\ [\%] = \frac{Qty.\ of\ on-spec\ product\ in\ fraction}{Qty.\ of\ material\ of\ the\ specific\ fraction} \tag{II}$$

The following two schemes will clarify the relations.

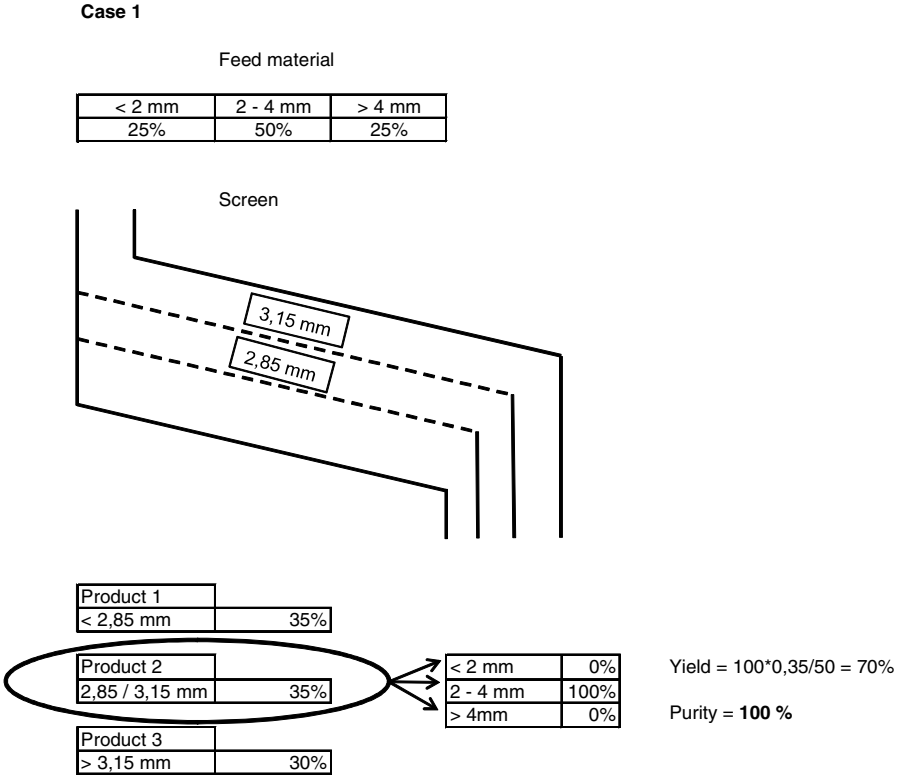

Figure. 1. Case study 1

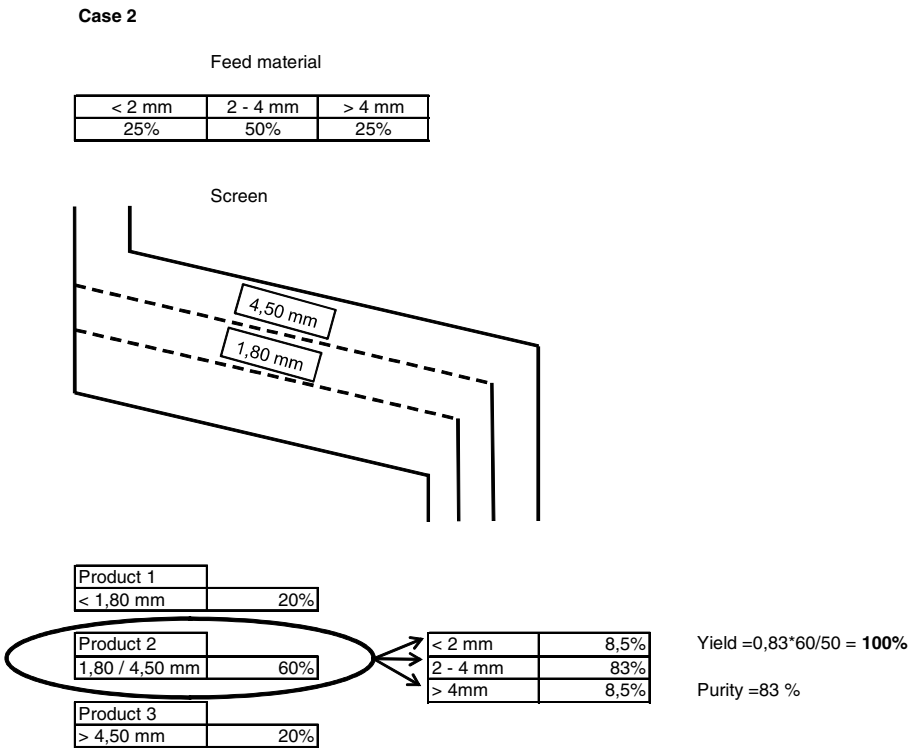

Fig.ure 2. Case study 2

Of course there are screen specific interrelations between the purity, yield and throughput of a screen type. In general a high throughput makes it more difficult to produce a high quality. Furthermore the amount of product in the feed material has an influence on the purity and yield that can be obtained.

In general it is easier to achieve a high purity value when the amount of on spec material in the feed is high. The lower the amount of on spec material gets the harder it will be to gain a product with a high purity and a high yield. Having these basic interrelations in mind it becomes easier to understand the special exigencies modern plants are demanding of screening technologies.

3. Influence of screen quality on fertilizer production

Screening machines can either be used in a grinding and classification circuit or as an inline aggregate without recirculation. In case of using the screen in a grinding and classification circuit material that does not meet the specified product requirements causes the circular mass flow to rise which leads to many problems such as higher wear, lower product rates and higher power consumption. It is therefore absolutely undesirable if on spec product is lost in the overflow fraction.

For the second possibility of using screens inline as a last classification step for adjusting the product quality a malfunction of the screen can lead to severe impacts on the product price.

Modern fertilizer plants have capacities of up to several thousand tons a day. Fertilizers produced as rock, prills or granulates have to be screened in order to fulfill the clients´ requirements.

A typical product specification might be for example a product with 90 % of on spec material between 2 – 4 mm and 3 % > 4 mm, 7 % < 2 mm.

Regarding the plant it is easy to understand that an optimal product yield has two main advantages for the plant manager.

- First the amount of re-circulated material is kept low which allows a higher production rate of the plant and reduces the costs of reprocessing on spec material.
- Second the amount of product is increased.

A short calculation for a production line that generates 2400 t/d with an on spec share of 25 % and different screen types demonstrates how the yield will affect the plant efficiency. This calculation is only a rough estimation because the prices for fertilizers are subject to strong variations and the amount of on spec material also differs in every plant. In order to generate 2400 t/d the average capacity has to be higher than 100 t/h. Thus the calculation is made up with an average feed of 100 t/h. Furthermore three screen types with different characteristics are compared. The On Spec product fraction shall constitute 25 % of the feed material which equals to 25 t/h. Based on the different values for Yield and Purity of each screen different amounts of product and quality can be generated. Taking into consideration that the amount of product that has to be re-circulated due to a lower yield generates costs and cannot be sold a calculation of the costs due to poor screen quality can be made up. By neglecting the costs for recirculation and only taking into account the costs for product loss one can easily see that every percent of higher yield has a severe economic impact.

The condensed information of these calculations is presented in table 1.

Table 1. Influence of screen parameter on product amounts

	On spec [t/h]		Yield [%]		Yield [t/h]
Screen a	25	*	**85%**	=	21,3
Screen b	25	*	**90%**	=	22,5
Screen c	25	*	**95%**	=	23,75

	On spec [t/h]		Yield [t/h]		Re-circulated material [t/h]
Screen a	25	-	21,3	=	3,75
Screen b	25	-	22,5	=	2,5
Screen c	25	-	23,75	=	1,25

	Re-circulated material [t/h]		Price [$/t]		Cost recirculation/year [$]
Screen a	3,75	*	250	=	8.100.000
Screen b	2,5	*	250	=	5.400.000
Screen c	1,25	*	250	=	2.700.000

Table 2. Economic benefit of high precision screens

	[$/y]
Benefit screen a to screen b	**2.700.000**
Benefit screen a to screen c	**5.400.000**

It becomes obvious that very small improvements can have a high influence on the financial result of a plant. The financial return on invest of a high quality screen compared to a low quality screen or the wrong screen type will be by far less than half a year.

4. MDS Machine

The following figure shows the principle layout of the MDS machine.

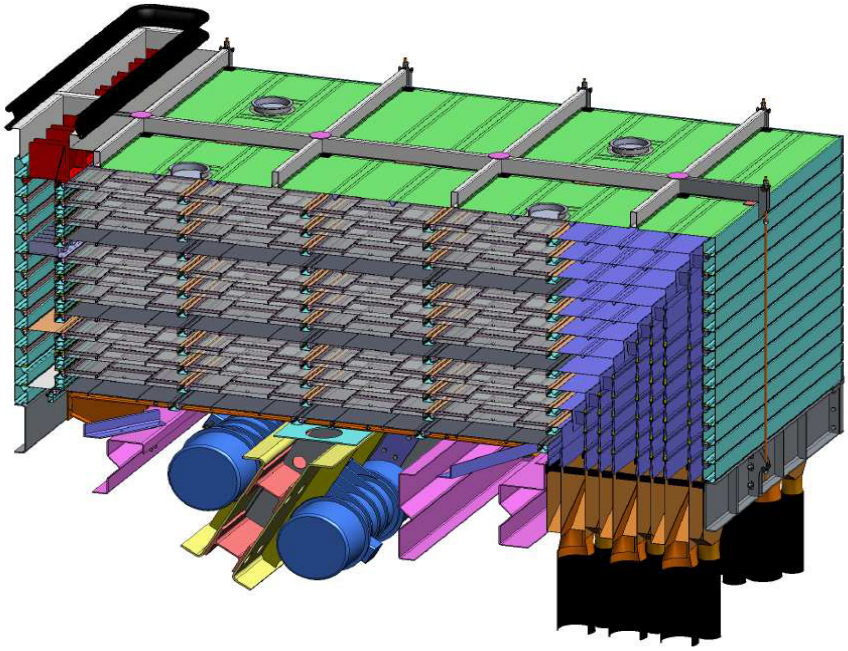

Figure 3: Multi Deck Screening Machine

The MDS screen consists of several screen decks which are placed above each other. By doing so a multitude of products can be generated simultaneously. If the aim of the process is to generate only few products with a high throughput rate it is possible to use the technological unit concept of the MDS.

One of the main advantages of the MDS machine is the construction in multiple technological units. A technological unit can be understood as an independent screen. In the figure three technological units can be distinguished as they are limited by the dark grey ground plates. The feed material of the MDS is separated into equal shares depending on the number of technological units. Thus the screen surface and the screen throughput is multiplied by the number of technological units.

A further reason for the precision of the MDS machine is the efficient de-clogging of the screen cloth. For de-clogging bouncing balls are used which can move freely between the supporting mesh and the screen cloth. The special form of the bouncing balls enables them to even clean the corners of the screen cloth. This is of high importance because there is no reduction of the open screen surface during the entire work life of the screen cloth. Especially for Fertilizers which often have the tendency to get stuck in normal screen cloth these de clogging devices are crucial for a satisfactory operation of the screen. The following figure shows the screen insert of a MDS machine after 160 h of operation. The white parts of the screen cloth show the effect of operation without the de clogging devices.

Figure 4: Influence of de clogging devices

5. DF Machine

A further screen type which can be used for the medium to coarse classification of fertilizers is the double frequency screen. The working principle of this machine is illustrated in the following figure.

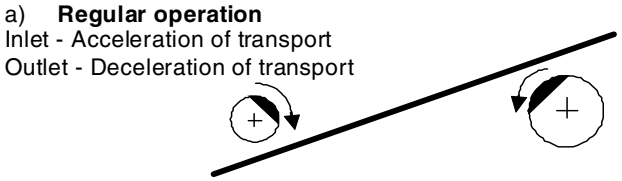

Figure 5: Movement Schematic DF screen

Due to the different imbalance weights of the inlet and outlet motor different amplitude and transport direction on the screen mesh can be achieved. The high imbalance weight and anti-clockwise rotation of the imbalance motor at the inlet of the screen leads to high amplitudes of the screen mesh and a high transportation speed. Thus the amount of easy to sieve material will be removed fast on the first part of the screen mesh.

On the second part of the screen mesh the clockwise rotation and the lower imbalance weight of the motor at the outlet of the screen gains more influence. Thus a smaller swinging amplitude at the outlet of the screen is generated which leads to a more frequent contact of particles and screen cloth. Furthermore the clockwise rotation at the end of the screen mesh reduces the transport speed which has the effect that the reduced amount of material can last longer on the screen cloth, which also raises the probability for a particle to pass the screen cloth. A further advantage is that the position of the imbalance motors allows the treatment of very hot feed material.

6. Summary

The present paper explains the importance of the choice of the screen for fertilizer production plants. It becomes apparent that the choice of the right screen type can have a major influence on the effectiveness of a plant even though the differences between the screens might be small on the first sight.

RHEWUM as a producer of first class screens for the fertilizer industry has therefore implemented several technological details in their screens in order to fit the process in the best available manner. A further very important step in the optimization of a plant can be the combination of different screen types. Furthermore, several other factors which do have an impact on the screening performance have to be considered such as the wear of the machine and the associated use for spare parts, the ease of maintenance, the average down time of a machine and the space requirements.

To help our customers finding the best solution we support them from the concept study to the plant operation. Our vast knowledge in process engineering and screening technology is the entrance for a safe plant layout fulfilling the highest requirements.